

# MONTHLY WEATHER REVIEW.

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## INTRODUCTION.

The REVIEW for August, 1894, is based on reports from 3,239 stations occupied by regular and voluntary observers. These reports are classified as follows: 149 reports from Weather Bureau stations; 41 reports from U. S. Army post surgeons; 2,284 monthly reports from State Weather Service and voluntary observers; 31 reports from Canadian stations; 246 reports through the Southern Pacific Railway Company; 386 marine reports through the co-operation of the Hydrographic Office, Navy Department, and "New York Herald Weather Service;" monthly reports from 37 U. S.

Life-Saving stations; 65 reports from navigators on the Great Lakes; monthly reports from local services established in all States and Territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

The WEATHER REVIEW for this month has been prepared under the general editorial supervision of Prof. Cleveland Abbe. Unless otherwise specifically noted, the text is written by the editor, but the statistical tables are furnished by the Division of Records and Meteorological Data, in charge of Mr. A. J. Henry, acting chief of that division.

## CHARACTERISTICS OF THE WEATHER FOR AUGUST, 1894.

The most prominent meteorological features of the month of August were the absence of well developed cyclonic storms over the United States and the adjacent portions of the Atlantic and Pacific oceans; the general prevalence of high pressure and dry, hot weather over the interior of the country; the extensive drought, covering the greater portion of the country, except the south Atlantic and Gulf States;

the excessive precipitation in western Texas and the consequent floods in the Rio Grande; the extensive forest and prairie fires, causing a cloud of smoke that overhung the country from Minnesota southward to Missouri and eastward to the Atlantic; the interesting aurora of August 19 and 20; the low water in the Mississippi River and its tributaries; the extreme southern limit reached by the ocean ice off the Banks of Newfoundland.

## ATMOSPHERIC PRESSURE.

[In inches and hundredths.]

The distribution of mean atmospheric pressure reduced to sea level, as shown by mercurial barometers not reduced to standard gravity and as determined from observations taken daily at 8 a. m. and 8 p. m. (seventy-fifth meridian time), during August, 1894, is shown by isobars on Chart II. That portion of the reduction to standard gravity that depends on latitude is shown by the numbers printed on the right-hand border. This Chart also gives the so-called resultant wind directions for this month, based on the data given in Table IX of this REVIEW.

During the current month of August pressures have been highest, 30.08, in southeastern Florida, and nearly as high, 30.06, in the northwestern corner of Washington. The average lowest pressure was 29.81 at Yuma; the region of 29.85, or less, extended from central California southeast into the northwest portion of Mexico. A similar region of low pressure, 29.90, is found on the eastern slope of the Rocky Mountains, extending from western Saskatchewan southward into eastern Montana. In general, it would seem that the low pressure extending from the Gulf of California northward into British America as a trough between the high areas over the Pacific and Atlantic oceans owes its existence to the presence of the

Rocky Mountain, the Andes, and the west coast ranges rather than to the existence of the continent on the east side of these mountains; the heated air of the continent is not so important a factor in the production of low pressures as is the obstruction offered by the mountain ranges to the movements of the atmosphere.

The normal distribution of atmospheric pressure and normal resultant wind direction for the month of August were approximately shown on Chart V of the REVIEW for August, 1893, as computed by Prof. H. A. Hazen, and are not now reproduced. As compared with the normal for August, the mean pressure for the current month was above the normal in Manitoba, Ontario, and Quebec, the maximum excess being 0.07 in Manitoba; pressure was also above the normal from British Columbia southeastward to Texas, the maximum excess being 0.09 at Denver; pressure was above the normal in California and Arizona, but below the normal on the coast of Oregon as also in New Brunswick and Nova Scotia. In general, therefore, except for these small areas of deficit, pressures were everywhere above the normal for August.

As compared with the preceding month of July, the pressures reduced to sea level show a fall of 0.09 on the coast of

Oregon and Washington, and 0.05 on the coast of North Carolina, but a rise, 0.10, in Manitoba. The line of no change passes from Cape Breton south to N. 40°, southwest into Virginia, west-northwest through Nebraska, southeast into Arkansas, and southwest through Texas; it reappears on the Gulf of California, passes northward between Utah and Wyoming, northwestward through Montana and Alberta, and along the Rocky Mountain Divide into British Columbia.

#### DIURNAL VARIATIONS.

The systematic periodic diurnal variations of pressure are shown by the hourly means given in Table VI.

#### AREAS OF HIGH AND LOW PRESSURE.

The following sections give some details as to the phenomena attending the individual areas of high and low pressure. The storm warnings officially issued by the Weather Bureau either through the general forecast official at Washington, or by the respective local forecast officials, are enumerated in connection with the respective areas of disturbance.

#### MOVEMENTS OF CENTERS.

The following table shows the date and location of the center at the beginning and ending of each area of high or low pressure that has appeared on the U. S. Weather Maps during the month, together with the average daily and hourly velocities. The monthly averages will differ according as we consider each path as a distinct unit, or give equal weight to each day of observation; in the first case the monthly average is taken by paths, in the latter case by days.

*Movements of centers of areas of high and low pressure.*

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
<b>High areas.</b>										
I.....	1, a. m.	52	113	11, a. m.	31	88	3,600	10.0	360	15.0
II.....	1, a. m.	47	74	4, a. m.	47	56	1,000	3.0	333	13.9
III.....	4, a. m.	46	127	5, a. m.	46	122	300	1.0	300	12.5
IV.....	9, a. m.	50	87	14, a. m.	45	58	1,900	5.0	380	15.8
V.....	9, a. m.	44	122	17, a. m.	44	109	600	2.0	300	12.5
VI.....	14, a. m.	53	99	18, a. m.	40	72	1,700	4.0	425	17.7
VII.....	20, a. m.	51	90	23, a. m.	37	77	1,100	3.0	367	15.3
VIII.....	23, a. m.	50	101	26, a. m.	42	98	600	3.0	200	8.3
IX.....	25, a. m.	48	128	31, a. m.	45	90	2,000	6.0	333	13.9
Sums.....							12,800	37.0	2,998	
Mean of 9 paths.....									333	13.8
Mean of 37 days.....									346	14.4
<b>Low areas.</b>										
I.....	1, a. m.	47	91	5, a. m.	49	47	1,600	4.0	400	16.6
II.....	2, p. m.	52	115	6, p. m.	45	92	1,300	4.0	325	13.6
III.....	6, p. m.	50	104	7, p. m.	43	100	600	1.0	600	25.0
IV.....	4, a. m.	28	87	9, a. m.	31	91	500	5.0	100	4.2
V.....	8, p. m.	44	75	10, a. m.	46	58	850	1.5	567	23.6
VI.....	7, p. m.	50	112	10, p. m.	44	98	800	3.0	267	11.1
VII.....	11, p. m.	51	120	16, a. m.	48	58	3,600	4.5	800	33.3
VIII.....	14, p. m.	52	112	18, p. m.	49	69	2,000	5.0	400	16.7
IX.....	17, p. m.	50	115	19, p. m.	42	101	900	2.0	450	18.8
X.....	18, p. m.	52	115	20, p. m.	52	106	400	2.0	200	8.4
XI.....	19, a. m.	38	79	22, a. m.	49	52	1,700	3.0	567	23.6
XII.....	20, p. m.	53	115	24, a. m.	51	61	2,700	3.5	772	32.2
XIII.....	21, a. m.	30	103	26, a. m.	37	86	1,400	5.0	280	11.7
XIV.....	22, p. m.	39	123	30, a. m.	46	42	4,100	7.5	547	22.8
XV.....	26, a. m.	51	115	31, p. m.	48	61	3,000	5.5	545	22.7
XVI.....	30, p. m.	54	116	31, p. m.	50	109	700	1.0	700	29.2
Sums.....							26,150	57.5	7,520	
Mean of 16 paths.....									470	19.6
Mean of 57.5 days.....									455	19.0

#### HIGH AREAS.

I.—Beginning on the 1st, a. m., in Alberta, this moved eastward on the 2d and southeast on the 3d, when it was central in eastern Dakota; on the 4th in Iowa; 5th, a. m., in Ohio, at which time high pressure prevailed from Texas to Lake Superior, thence to Maine and southward to North Carolina; 6th, a. m., Pennsylvania; 7th, a. m., North Caro-

lina; 8th, a. m., off the coast of Georgia; 9th and 10th, a. m., in northern Alabama; 11th, a. m., in southern Alabama; after this an area of high pressure remained in the Gulf of Mexico and the southern portion of the Gulf States until the 17th and, with occasional interruptions, throughout the month.

II.—On the 1st, a. m., pressure was slightly above normal in the St. Lawrence Valley, and on the 2d, a. m., in New Brunswick; 3d, a. m., in Newfoundland; 4th, a. m., south of Newfoundland, after which this high pressure disappeared.

III.—On the 4th, a. m., pressure was highest off the coast of Oregon, and the 5th, a. m., within that State, after which the pressure again declined.

IV.—On the 8th, a. m., pressure was rising, with northerly winds in Manitoba and the Lake region northward to Hudson Bay. On the 9th, a. m., pressure was highest north of Lake Superior; 10th, a. m., at the eastern end of Lake Superior; 11th, a. m., in New England; 12th, a. m., southwest of Nova Scotia; 13th, a. m., in southern Newfoundland; 14th, a. m., south of Newfoundland, after which this area disappeared.

V.—On the 9th, a. m., pressure was rising in British Columbia, and on the 10th, a. m., it was highest there; 11th, a. m., it was highest in Assiniboia; by the 12th, a. m., this high pressure had spread in all directions and the center could no longer be located.

VI.—On the 13th, a. m., pressure was again rising in British Columbia, and apparently in the regions to the northward, so that on the morning of the 14th the pressure was highest in Manitoba; 15th, a. m., northern coast of Lake Superior; 16th, a. m., northern portion of Lake Michigan; 17th, a. m., in Ohio; 18th, a. m., off the middle Atlantic coast, after which this can no longer be traced.

VII.—On the 19th, a. m., while pressure was low in Manitoba it was rising on the north and east; by the 20th, a. m., the highest pressure of the month was central north of Lake Superior. During the evenings of the 19th and 20th occurred the principal auroral display elsewhere described. 21st, a. m., highest pressure was on the northern border of Lake Superior; 22d, a. m., it was central on the southern portion of Lake Huron; 23d, a. m., to 25th, a. m., in Virginia; 26th, a. m., pressure had generally fallen and the central highest pressure had disappeared.

VIII.—On the 22d, a. m., pressure was rising in Assiniboia, in the rear of low No. XIII, and by the 23d, a. m., high pressure No. VIII was central in that region; 24th, a. m., it was central in North Dakota; 25th, a. m., in South Dakota; 26th, a. m., in Nebraska; at this time the area of high pressure stretched as a ridge from Colorado northeastward over Lake Superior into Labrador. By the 27th, a. m., this ridge had divided into two portions, respectively central in New Mexico and New England, after which these disappeared in the general high pressure that prevailed over the eastern half of the United States.

IX.—On the 24th, a. m., pressure was rising off the coast of Oregon, and on the 25th, a. m., it was highest in northwestern Washington, while low No. XV was moving east into Manitoba. By the 27th, a. m., the highest pressure was apparently in Stikine, and on the 28th, a. m., in Alberta; on the 29th, a. m., in Assiniboia, but stretching east and west from British Columbia into Manitoba; 30th, a. m., highest in Manitoba but again stretching as a ridge from Alberta southeast into Wisconsin; 31st, a. m., central in Wisconsin.

#### LOW AREAS.

During the month of August a number of ill-defined areas of low pressure have passed along the northern border of the United States, and it is believed that all depressions marked as "low" on the Daily Weather Map have been included in the following list:

I.—This number is given to the low area of Arizona and the Gulf of California. The pressure at Yuma, as reduced to sea level, was lowest at 8 p. m. on the following dates: 2d, 29.68; 6th, 29.71; 11th and 12th, 29.74; 17th, 29.71; 23d, 29.70; 30th and 31st, 29.75. These six minima represent low pressures averaging slightly below those of the corresponding six minima recorded during July. They occurred, as usual, in connection with the formation of troughs of low pressure in British Columbia. They do not represent cyclonic whirls moving over the surface of the globe, nor even stationary whirls, but the central troughs of successive low pressures formed in connection with the high pressures over the Pacific Ocean.

In general, the monthly and annual averages of local pressures give monthly and annual isobars inclosing areas of high and low pressure that must not be regarded as even approximately representing conditions of static equilibrium nor even of dynamic equilibrium, or the so-called steady motion. The passage over a given station of a preponderating number of low areas due to cyclonic whirls will produce a monthly average low pressure in the neighborhood of that station, but such a one as could not be maintained steadily in the presence of the high pressures shown by the monthly averages in its neighborhood. It would, therefore, be quite illogical to compare the monthly average isobars, isotherms, and winds in the neighborhood of such a region and seek to deduce any simple connection between them; the connection must be deduced primarily from the study of the individual simultaneous observations.

II.—This depression moved southeast into the Lake region, where it was central on the 1st, after which it moved northeast. It was attended with light rain on the 1st, but heavy rain on the 2d in most portions of the Middle and Eastern States. It disappeared on the 4th at the mouth of the St. Lawrence, but the area of low pressure remained near Newfoundland on the 5th and became area *B* of the North Atlantic series.

III.—This began on the 2d, p. m., in British Columbia at the northern end of the trough extending from the Gulf of California. The extensive area of high pressure, No. II, at that time stretched from Manitoba northward and southward, and as it moved southeast low area No. III moved eastward on the 3d and southeast on the 4th into North Dakota. Very little rain attended this low pressure and it gradually dissipated.

In anticipation of the approach of this disturbance signals were ordered as follows: Chicago, 4th, 10 p. m., northwest signals ordered for Lake Huron and at Grand Haven, Milwaukee, Green Bay, and Marquette; northeast signals at Chicago. Chicago, 5th, 10.20 p. m., warnings of severe local storms for Minnesota, North and South Dakota. Chicago, 6th, 10 a. m., southwest signals ordered for Alpena, Sault Ste. Marie, Green Bay, and Marquette. Chicago, 8th, 10.40 p. m., warnings of severe local storms for Wisconsin and Upper Michigan.

IV.—On the 6th, p. m., in the northern portion of the general depression containing low No. III, there appeared another low center, which is numbered IV. This extended southward, attended by high local winds, and disappeared on the 7th, p. m.

V.—On the 4th, a. m., the winds, as reported from the eastern portion of the Gulf of Mexico, indicated the presence of a cyclonic whirl. By the 5th, p. m., its presence east of Port Eads was clearly indicated, and by the 6th, p. m., the northerly wind of 34 miles at that point indicated its near approach. The progress of the whirl seems to have been nearly due north; it passed a little to the west of Pensacola about midday of the 7th, and then moved slowly westward, disappearing on the 9th in southern Mississippi. Very heavy rain

attended this storm, whose dimensions, wind velocities, and slow movement entitle it to be classed in a category somewhere between the waterspout and the hurricane, but distinct from the ordinary tornado.

VI.—This depression appeared well defined on the map of the 9th, a. m., on the southeast side of the area of high pressure No. IV, which was at that time advancing southward into the very extensive depression left by the breaking up of the preceding low areas, Nos. III and IV. A trough was thus formed between the St. Lawrence Valley, where northerly winds prevailed, and the middle Atlantic States and New England, where southerly winds prevailed. This trough moved northeastward and by the 10th, a. m., had become a well-defined whirl near Newfoundland, after which it became the low area *B* of the North Atlantic series.

VII.—On the 7th, p. m., pressure was below the normal throughout the Rocky Mountain plateau, and several special depressions were indicated by the isobars. Area No. VII, in the southern portion of Alberta, apparently began its development at that time; during the 8th and 9th it moved southeastward, reaching South Dakota by the 10th, p. m., at which time a trough extended from Nebraska to Manitoba. The southern end of the trough then filled up, and the northern end retired northeastward without becoming an important disturbance.

VIII.—On the 11th, a. m., pressure was again low throughout the Rocky Mountain region from Mexico to British Columbia. The southern end of the trough belongs to the depression No. I, while the northern end moving southeastward receives the number VIII. By the 13th, p. m., it had reached the southernmost point of its path in Nebraska, after which it moved northeast and disappeared on the 16th in Newfoundland.

IX.—On the 14th, p. m., barometric conditions were very similar to those of the 15th, p. m., pressure being low throughout Alberta, Assiniboia, and Saskatchewan. Apparently a moderate depression had moved southeastward from British Columbia on the 13th, and by the 16th, p. m., it was central in Manitoba, and high winds, attending local storms, were reported from South Dakota. During the 17th this depression moved eastward on the northern border of the Lake region, where local rains and occasional wind gusts were reported. During the 18th and 19th low pressure, with light rains, prevailed over the Middle States and New England, while the central lowest pressure was far to the northward and disappeared over the Gulf of St. Lawrence.

In connection with this storm the following signals were ordered: Chicago, 17th, 10 a. m., southwest signals for Sault Ste. Marie and Marquette.

X.—While No. IX was near Lake Superior another depression began in Alberta on the 17th, p. m., and moved rapidly southeastward, disappearing on the 19th, p. m., in Nebraska.

XI.—While No. X was moving southeast through South Dakota another depression began in Alberta on the 18th, p. m., and moved slowly eastward, reaching the central portion of Assiniboia by the 20th, p. m., where it disappeared.

XII.—On the 19th, a. m., a depression had begun to form in West Virginia which, after moving eastward, turned to the northeast along the New England coast, with increasing winds; on the 21st it passed over Newfoundland, and on the 22d, a. m., it was apparently central near the coast of Labrador, after which its history is given as area *F* of the North Atlantic series.

XIII.—On the 20th, p. m., an area of low pressure existed in Alberta, which was in fact but a continuation of low No. XI, which now began to move eastward after having sent off the smaller depressions Nos. X and XI. By the 23d, p. m., this depression had passed eastward to the north of the St. Lawrence, after which it disappeared.

XIV.—During the 21st the high pressure advancing southward over the Lake region indicated that a decided disturbance must exist far to the south. In northern Mexico and in western Texas a slight barometric depression appeared on the morning of the 22d. This depression moved eastward, reaching the Mississippi on the 23d, at which time also pressure was lowest at Yuma. Low pressure continued in the lower Mississippi valley until the 26th, with a moderate and ill-defined cyclonic circulation of the winds and general rains.

XV.—This depression appears to have begun on the 22d, p. m., in northern California, as a cyclonic whirl, between the northerly winds on the coast and the southerly winds in the interior; it moved northward into British Columbia and thence eastward along the northern border of our stations, disappearing on the 30th southeast of Newfoundland.

On the 26th, p. m., as this depression approached Lake Superior the following signals were ordered: Chicago, 26th,

10.30 p. m., warnings of severe local storms for Upper and Lower Michigan.

XVI.—On the 26th, a. m., pressure was still rising in British Columbia and Alberta in the rear of low No. XV, but by the 26th, p. m., had again begun to fall, owing to the formation of low No. XVI which moved southeastward into South Dakota, while low No. XV moved rapidly eastward. On the 28th, p. m., No. XVI extended as an indefinite depression from South Dakota to Idaho, between northerly and southerly winds, but by the 29th, a. m., the western end had closed up and the eastern end was a well-defined low area, central in southern Michigan. It moved eastward, reaching the St. Lawrence Valley on the 30th, sending a temporary depression southeastward into New England. The main center disappeared on the 31st in the Gulf of St. Lawrence.

XVII.—This depression began on the 30th, p. m., in Alberta and on the 31st, p. m., was central in Assiniboia. Its further history belongs to September.

## NORTH ATLANTIC METEOROLOGY.

[Pressure in inches and millimeters: wind-force by Beaufort scale.]

### NORMAL CONDITIONS.

The normal barometric pressure for August over the North Atlantic Ocean, as deduced from international simultaneous meteorological observations taken at Greenwich noon and reduced to standard gravity, is highest, 30.20 in a small region between N. 30° and N. 40°, W. 23° and W. 48°; it is lowest, 29.70 (754), in two small regions (1) north of Hudson Bay; (2) between Iceland and northeastern Greenland. On the Pacific Ocean a similar area of high pressure prevails between N. 40° and N. 20°, and west of W. 140°. From this Pacific area a narrow prolongation extends northeastward to Vancouver Island, giving high pressures to the coast of Oregon. In general, the pressure is low, 29.80 or less, over the entire Polar region north of N. 60°, but is higher in northern Siberia than in northern America.

As compared with July the normal pressures for August are higher throughout the United States, British America, the Polar regions, and Asia, but lower over the Atlantic and Pacific oceans. These changes are such as to indicate that between the 5th and 10th of August the distribution of pressure in the Northern Hemisphere has reached the extreme condition peculiar to summer temperatures, and by the 15th of August has already begun its retrograde movement toward the condition appropriate to midwinter. As these barometric changes are the result of corresponding changes in the general circulation of the atmosphere, whereas the temperatures at the surface of the earth show no such decided thermal retrogression until some weeks later, we must conclude that the seasonal changes take place more promptly in the upper strata of the atmosphere than in the lower, or in other words that the mobility of the upper portion of the atmosphere is greater than that of the lower portion, a conclusion that is entirely in accordance with the well-recognized fact that the lower layer of air experiences various forms of resistance from the earth's surface and the ascending currents of warm air, while the upper layers glide over these with comparatively little resistance. The first effect of the southward motion of the sun is to diminish the quantity of heat received by the surface of the land and ocean in the Northern Hemisphere; this effect is felt in the regions north of N. 60° between June 15 and August 15, more than in the regions to the south of it, and the first result is not so much a diminution of temperature at the surface of the earth as a diminution of the ascending component of the atmospheric motion.

The normal zone of maximum frequency of paths of

centers of low pressure during the month of August passes from some unknown point on the coast of Alaska southeastward to Lake Superior, thence eastward over Newfoundland and northeast to the Faroe Islands, thence eastward into central Russia. The general distribution of pressure indicates that these special areas of low pressure begin as whirls in the upper atmosphere attending the overflow from the high pressure of the Pacific northeastward over Alaska into the low pressure of the Arctic; they are propagated eastward as incidents in the general overflow from the tropical areas of high pressure. The number of such whirls as recorded is less in August and the summer months than in December and the winter months, but this is partly explained by the fact that the whirls occur on the extreme northern limits of our reports and partly by the probability that some of those in the upper layers do not extend down to the surface of the ground with sufficient definiteness to be recognizable on our maps. The other prominent belts of storm tracks are those that pass northeastward through the China and Japan seas and those that pass over the West Indies westward to the Florida coast and thence northeast to Newfoundland. These storms represent whirls that originate in the tropical regions whenever the cold, dry air descending over continental areas, such as China, the United States, Brazil, or northern Africa, has an opportunity to intrude into the moist air of the tropics.

The normal rate of progress of storm centers during August is 26 miles per hour when moving eastward in the northern portion of the United States, 23 miles per hour when moving east over the North Atlantic Ocean, 18 miles per hour when moving eastward through Europe, and 20 miles when moving northeast through the China and Japan seas and the northern portion of the Pacific Ocean. Tropical storms moving westward average 18 miles per hour in the West Indies and 10 miles per hour in the East Indies.

### NORTH ATLANTIC STORMS.

The following paragraphs give some account of the areas of low pressure and strong winds on the North Atlantic Ocean during August, 1894. Daily charts are compiled at the Weather Bureau showing the atmospheric conditions over the United States, Europe, and the Atlantic Ocean, as nearly as practicable at Greenwich noon, and afford a basis for approximating the locations and paths of the more important areas of high and low pressure.